trapolate to human beings. Among populations of working people exposed to microwave fields there is a wealth of clinical opportunity for research, but the problem is, as always, what to look for. Much work has been concentrated on discovering the threshold of specific macroscopic damage to discrete organs such as the formation of cataracts in eye lenses. It was upon such work that the present 10 mW/cm^2 safety level has been based. The Russian standards, which are not based on such heating effects, cause much heart-searching among occupational health physicians. Instead of seeking gross pathologic changes resulting from microwave exposure, we should be on guard against the occurrence of more subtle effects, which detract from industrial comfort or an individual's efficiency. For instance, recent work has shown that protracted exposure to low power microwave fields can cause small vacuole formation and abnormal striation in the eye lens. While this causes no discernible opacity, it would cause impairment of the lens elasticity. The focusing capacity is therefore impaired, and the usual onset of presbyopia in middle life occurs at an earlier age. Investigations into changes of this degree in human populations are advocated, and preventive measures are discussed.

4684 A TRIAL INVOLVING THE USE OF PULSED ELECTRO-MAGNETIC THERAPY ON CHILDREN UNDERGOING ORCHIDOPEXY. (Eng.) Bentall, R. H. C. (Dept. Applied Physiology, Royal Coll. Surgeons, Lincoln's Inn Fields, London, England); Eckstein, H. B. *Z. Kinderchir.* 17(4): 380-389; 1975.

The effect of postoperative non-thermal pulsed high frequency electromagnetic therapy on bruise healing and edema formation was evaluated during a double blind trial involving 50 paired boys undergoing orchidopexy. Electromagnetic therapy was given 3 times a day for the first 4 postoperative days and consisted of the local administration of 500 pulses/sec at a penetration of 5 for 20 min followed by a second application of 500 pulses/sec at a penetration of 4 to the epigastrium for 10 min. Patients so treated showed a significant increase in bruise resolution rate as well as a trend toward increased rate of reduction of scrotal circumferential measurement. No side effects were observed, nor was there any difficulty experienced in the application of this nonthermal therapy. It is concluded that previously reported beneficial effects of this therapy on bruise resolution and edema reduction were confirmed. (33 refs.)

4685 EFFECTS OF TRANSCEREBRAL ELECTROTHERAPY (ELECTROSLEEP) ON STATE ANXIETY ACCORDING TO SUGGESTIBILITY LEVELS. (Eng.) Ryan, J. J. (Psychology Service, Veterans Admin. Hosp., North Little Rock, AR); Souheaver, G. T. *Biol. Psychiatry* 11(2): 233-237; 1976.

Transcerebral electrotherapy (TCET) was tested for its ability to relieve anxiety in 24 (23 men and 1 woman, aged 21-59 yr) psychiatric inpatients. Subjects completed the State Anxiety Inventory (SAI). On the basis of the Harvard Group Scale of Hypnotic Susceptibility scores the patients were assigned to a high or low suggestibility group (12/group). These subjects were again assigned to an active TCET or placebo condition (6/group). The TCET group received a burst of current at a rate of 100 Hz/sec with a width of 2 msec for 30 min for five sessions on consecutive days. Controls received no electrical stimulation other than that delivered at an initial adjustment and 15 min readjustment period. Six to nine days following the last treatment each subject again completed the SAI. These scores indicated that for the low and high suggestibility groups the pre- and post-scores changed from 58.33 to 43.50 and from 57.66 to 50.66 respectively. Subjects in the active TCET condition showed significantly greater anxiety reduction than the control group ($p< 0.01$, $F=8.26$). There was no overall effect of suggestibility, nor was there a significant interaction between suggestibility and type of treatment ($p>0.10$, $F=2.89$). Likewise there was no differential response between the low- and high-suggestible control subjects ($F=<1$). (14 refs.)

4686 CONSIDERATIONS OF CHAMBER DESIGN, ENVIRONMENTAL CONTROL, AND MICROWAVE FIELD INTERACTIONS IN SMALL ANIMAL EXPERIMENTATION. (PROCEEDINGS ABSTRACT). (Eng.) Houk, W. M. (Naval Aerospace Medical Research Lab., Pensacola, FL); Grissett, J. D.; Longacre, A., Jr. *In: Proceedings of the 1975 Annual Meeting of the International Union of Radio Science Held at the University of Colorado, Boulder, Colorado, 20-23 October, 1975.* USNC/URSI. (Washington, D.C.): 137; 1975.

The criteria for design and performance of a facility utilized for studying microwave biologic effects in rats weighing up to 500 g were investigated. The results of using a 1.2 x 1.2 x 1.2 m semi-enclosed anechoic exposure chamber including field measurement techniques, material selection, environmental control, and biologic experimental design are discussed, with an analysis of the problems encountered in its use. The problems were related to certain biologic parameters studied in a finite experiment dealing primarily with environmental control, field measurements, and the simultaneous use of several subjects in the enclosure. Using the same basic design and performance criteria as the first experimental chamber, a second larger and more sophisticated semi-enclosed anechoic chamber, 1.8 x 1.8 x 1.8 m in size was constructed. This chamber addressed environmental control and microwave field parameters from its inception. Absolute requirements included: (1) a 2450 MHz microwave reference field located in the far field of a 15 dB standard gain horn showing no greater than ±1.0 dB variation over a 100 cm^2 working area; (2) an absolute temperature control of the environment where the experimental animals were located, in a range of 12.5 to 45°C, and control of ±0.5°C at the selected control point; and (3) a uniform air flow over the experimental animals with provision for dumping chamber air rather than recirculating it. Using the NBS XD-1 and EMD-1C microwave sensors, the field pattern alterations induced by polystyrene foam products used in the construction of animal enclosures was studied along with a standardized

method of measuring exposure levels. Using analogous techniques, field amplitude patterns around single and multiple experimental animals were derived along with energy absorption estimates made from standing wave patterns created by the animals. (No refs.)

4687 NUMERICAL STUDY OF ELECTROMAGNETIC POWER DEPOSITION IN BIOLOGICAL TISSUE BODIES (PROCEEDINGS ABSTRACT). (Eng.) Barber, P. W. (Dept. Bioengineering, Univ. Utah, Salt Lake City, UT). *In: Proceedings of the 1975 Annual Meeting of the International Union of Radio Science Held at the University of Colorado, Boulder, Colorado, 20-23 October, 1975.* USNC/URSI. (Washington, D.C.): 229; 1975.

The extended boundary condition method (EBCM) was applied to the problem of obtaining quantitative power absorption information for a homogeneous prolate spheroid model of man. It is known that this technique can readily be applied to power deposition calculations for man at relatively low frequencies. The EBCM and the long wavelength analysis method give exactly the same results at 10 MHz. This study was concerned with making calculations at higher frequencies to determine the frequencies of maximum absorption, i.e., the resonant frequencies of man. Extension of the numeric work to bodies that are electrically larger required the consideration of various numeric problems, including the solution of an unusual set of simultaneous equations. Although the matrix involved was not ill-conditioned, the wide variation in the amplitude of the elements could result in appreciable error in the solution because of the finite precision arithmetic of the computer. This behavior, which is a consequence of the large dielectric constant of the muscle tissue used in the model, appeared to limit the application of the EBCM to frequencies below 100 MHz. This, however, did permit a determination of the first resonance. The numeric results gave the average power absorption and peak power absorption for man as a function of frequency, polarization, and orientation through the first resonance. (No refs.)

4688 DISTRIBUTION OF ELECTROMAGNETIC ENERGY DEPOSITION IN MODELS OF MAN WITH FREQUENCIES NEAR RESONANCE (PROCEEDINGS ABSTRACT). (Eng) Gandhi, O. P. (Dept. Electrical Engineering and Bioengineering, Univ. Utah, Salt Lake City, UT); Sedigh, K.; Beck, G. S.; Hunt, E. L. *In: Proceedings of the 1975 Annual Meeting of the International Union of Radio Science Held at the University of Colorado, Boulder, Colorado, 20-23 October, 1975.* USNC/URSI. (Washington, D.C.): 201; 1975.

Experimental results are described for whole-body absorption of a series of saline-filled and biologic-phantom figurines of major lengths (L) that varied from 0.4 to 1.5 λ. Measurements are also reported of α parameter values (ratio of mW/g of absorbed energy to mW/cm^2 of incident field energy) for different regions of the body. The energy distribution was measured for 12.1 and 18.4 cm tall figurines under free space irradiation at both 985 and 2450 MHz using the liquid crystal temperature probe. These results were compared to those obtained in the transverse electromagnetic mode parallel plate chamber, namely, of whole-body values for the 220-750 MHz frequency range with 12.1 and 18.4 saline-filled figurines and prolate spheroids of a/b=6. The highest intensity of energy deposition was observed for the neck region of the body in both free space and parallel plate exposure conditions. The α for the neck region was approximately 30 times that observed for the whole-body average. The α values for other parts of the body, in descending order of magnitude, were reported for the thighs, shins, chest, pudendal region, and the eye region. For figurines with the feet touching the ground plate of the parallel-plate chamber, maximum energy deposition was observed for the shins, with α=12 at 240 MHz ($L/\lambda \approx 0.15$). A monopole-above-ground chamber is presently under construction to permit assessment of ground effects and measurements of α values. (No refs.)

4689 CRITICAL ASPECTS OF HUMAN VERSUS TERRESTRIAL ELECTROMAGNETIC SYMBIOSIS (PROCEEDINGS ABSTRACT). (Eng.) Maxey, E. S. (Research Div., Miami Heart Inst., Miami, FL). *In: Proceedings of the 1975 Annual Meeting of the International Union of Radio Science Held at the University of Colorado, Boulder, Colorado, 20-23 October, 1975.* USNC/URSI. (Washington, D.C.): 314; 1975.

Man's terrestrial electrical environment includes electrostatic fields, magnetic fields, field modulations, and aerion (positive and negative) concentrations. Nature imposes harmonious variations in these four factors. Laboratory studies often attribute biologic changes to variations in a single factor without adequate consideration of the remaining variables. Humans exhibit revealing electric characteristics. Brain waves physiologically present at frequencies paralleling the terrestrial Schumann resonance and sferics, and states of conciousness and decision making abilities are correlatable to cerebral alpha, beta, and theta frequencies. Can brains be entrained to terrestrial field modulations in the same way that mammalian hearts become synchronized to external rotating magnets? Positive and negative aerions affect numerous biologic responses including blood pH and serotonin fluctuations, changes in pulmonary oxygen exchange efficiency, and variations in the degree of left/right electroencephalographic synchronization. The travel of all charged particles is influenced by both electrostatic and magnetic field factors. Currents induced into the human organism by earth's electric forces are subtle but biologically significant. It is recommended that working spaces such as aircraft cockpits, where rapid response and precise decision making are critical, be conditioned with regard to aerion concentrations, magnetic fields, electrostatic fields, and field modulations. (No refs.)

4690 IMPACT OF RADAR IRRADIATION ON HUMAN SYSTEMS. (Eng.) Natarajan, K. (No affiliation given); Jagannathan, N. *J. Inst. Electronics Telecommunication Eng.* 22(5): 326-329; 1976.

The impact of microwave radiation on the human body is discussed. Human exposure limits regarded as safe are 0.03 W/cm^2 for frequencies below 0.5 GHz and 0.02 W/cm^2 at frequencies higher than 3 GHz. An examination of the absorption of microwave energy by various human tissues in the frequency range of 0.15-10 GHz reveals that at 0.15 GHz the penetration is much deeper; whereas, at 10 GHz the energy is absorbed in or near the skin. Parts of the body that do not have blood vessels (chambers of the eye and the hollow viscera) are particularly vulnerable to electromagnetic radiation because the heat can dissipate only by conduction to the surrounding vascular tissues. A case of bilateral cataracts has been reported for a person subjected to an intermittent exposure of about 0.005 W/cm^2 at 1.7-3.4 GHz for 3 days and to a level of 0.12 W/cm^2 for a total of 2 hr. Precautions for avoiding the hazards associated with occupational exposure to electromagnetic radiation include increasing the height of microwave antennae, the use of reflective clothes and protective goggles, and field strength monitoring in potential exposure areas. (6 refs.)

4691 EXPERIMENTAL DEVELOPMENT OF SIMULATED BIOMATERIALS FOR DOSIMETRY STUDIES OF HAZARDOUS MICROWAVE RADIATION. (Eng.) Cheung, A. Y. (Dept. Radiology, Section Radiation Physics and Radiation Biology, Univ. Maryland at Baltimore, Baltimore, MD); Koopman, D. W. *IEEE Trans. Microwave Theory Techniques* MTT-24(10): 669-673; 1976.

Simulated biotissues for microwave radiation dosimetry studies at X-band frequencies and for S-band modeling experiments, which use miniature phantoms at X-band frequencies, were developed. The influence of material composition on the dielectric and heat properties of the materials was studied at frequencies of 8.5 and 10.0 GHz for two types of materials: one corresponding to tissues of high water content (muscle) and the other for bone and fat tissues. Based on measured dielectric properties using a short-circuit waveguide technique, a simulated bone material consisting of Laminac 4110 (a polyester resin), acetylene black, and aluminum powder was chosen. A muscle composition simulated by combining a gelling plastic Super Stuff (Whamo Manufacturing) with water, polyethylene powder, and sodium chloride was similarly chosen. Formulations for the properties of high-water-content materials are valuable for identifying phantom materials for many parts of the human body that have a wide range of dielectric properties. (8 refs.)

4692 EFFECTS OF ELECTROMAGNETIC FIELDS BELOW 30 MHz ON ANIMAL BIOLOGY. (Eng.) Pierluissi, J. H. (Lawrence Livermore Lab., Univ. California, Livermore, CA 94550). *Prepared by Lawrence Livermore Laboratory for ERDA under Contract No. W-7405-Eng-48.* (UCRL-51880): 14 pages; August, 1975.

The biologic consequences of exposure to electromagnetic fields below frequencies of 30 MHz are reviewed. Data obtained from triple-layer models of the human body indicated that electromagnetic absorption increased linearly with frequency in the region below 100 MHz. Differences in absorption for the various thicknesses typical of the human body were insignificant in the radiofrequency region, and calculations indicated an absorption of about 15% at 30 MHz. It is suggested that personnel working with electromagnetic pulse simulators be restricted to 1440 pulses over any 6-min period; 1 pulse/min produces a power density of 0.044 mW/cm^2, which is about 1/200 of the acceptable dose. The increase in body temperature for such exposures is estimated at 0.00009°C. Since the threshold of temperature-increase sensation on the surface receptors of humans is about 0.05°C, the thermal effects produced in humans by electromagnetic pulses are probably incapable of even generating sensations of warmth. Biologic effects of nonthermal origin resulting from human exposure to electromagnetic fields below 30 MHz include: vascular conditioned reflexes (static frequency, field intensity of 10,000 V/m); diurnal rhythmicity (10 Hz, 2.5 V/m); brachycardia (static, 2600 A/m); changes in reaction time (less than 12 Hz, about 2 V/m), and interference with cardiac pacemakers (0.5-1.0 Hz or 10-30 Hz at high-frequency communications levels for the latter frequency range). (39 refs.)

4693 A MICROWAVE APPLICATOR FOR *IN VIVO* RAPID INACTIVATION OF ENZYMES IN THE CENTRAL NERVOUS SYSTEM. (Eng.) Lenox, R. H. (Dept. Neuroendocrinology, Div. Neuropsychiatry, Walter Reed Army Inst. Res., Washington, DC 20012); Gandhi, O. P.; Meyerhoff, J. L.; Grove, H. M. 4pp., 1976 (available through Inst. of Electrical and Electronics Engineers, Inc., New York, N.Y., No. 601MT1014).

A microwave applicator for the *in vivo* rapid inactivation of rat brain enzymes is described. The applicator includes a WR 430 waveguide test cell and a 2450 MHz pulsed power source that delivers 3.5 kW of microwave power, which is matched to the complex load (rat's head) by a double screw tuner. The rat is placed in a plexiglas tube, which is wrapped with copper screening that acts as a cylindrical waveguide, and the shielded tube is inserted into the waveguide chamber. Uniformity of fields along the width of the waveguide (ear to ear of the animal) is obtained as a result of the symmetrical dielectric loading achieved with the rat head in that dimension. Improved uniformity of heating the brain is achieved in the rostral to caudal dimensions by attaching tapered aluminum shims to the broad faces of the waveguide. In the vertical plane, a slight heating gradient exists that apparently is due to the overheating of the abundant muscle on the ventral side of the brain. The exposure time required for enzyme inactivation is 2.8 sec. Measurements of cyclic adenosine monophosphate in the microwave-treated brain indicate rapid enzyme inactivation and the prevention of postmortem changes in enzyme activity associated with more conventional methods of sacrifice. Measurements of cyclic adenosine monophosphate and cyclic guanosine monophosphate have been made in 13 distinct re-

gions of the rat brain: cerebellum, brainstem, midbrain, substantia nigra, thalamus, hypothalamus, hippocampus, amygdala-pyriform cortex, septal nuclei, nucleus accumbens, olfactory tubercle, striatum, and cortex. (15 refs.)

4694 EFFECTS OF SMALL ELECTRICAL CURRENTS ON COLLAGEN IN SOLUTION. (Eng.) Eriksson, C. (Inst. Stomatology, Sch. Dentistry, Univ. Pretoria, P.O. Box 1266, Pretoria, 0001, South Africa); Jones, S. *S. Afr. J. Sci.* 72: 114-116; 1976.

The effects of small electrical currents on soluble collagen solutions made up from rat tail tendon were investigated. When a direct current of 15 μA was passed through a 400 μg/ml collagen solution (pH 6.80) via vertically placed stainless steel electrodes, a brown-colored interface denoting a boundary between two regions of apparently differing viscosity was observed. On the cathode side of the band, the solution appeared very viscous, indicating the presence of collagen. The phenomenon appeared to be one of collagen molecule aggregation rather than polymerization, and electron micrographs of the viscous band revealed no fibers. The passage of a 10-μA direct current through a 160 μg/ml collagen solution (pH 4.70) via vertically placed stainless steel wire electrodes did not produce a band-like structure, and there was no evidence of collagen molecule aggregation. When a 5-μA direct current was passed through an 80-μg/ml collagen solution (pH 6.50) via horizontal platinum electrodes, polymerization of the tropocollagen molecules into well-characterized fibers was observed in the form of a whitish band that formed concave to the cathode in a horizontal plane. Thus, different effects were observed for different current gradients and different collagen solutions. (8 refs.)

4695 DYNAMICS IN CHANGES OF THE CEREBRAL ELECTRIC ACTIVITY IN MENOPAUSAL PATIENTS DURING THE TREATMENT OF PULSE CURRENT. (Rus.) Persianinov, L. S. (All-Union Scientific Research Inst. Obstetrics and Gynecology, USSR Ministry of Public Health, Moscow, USSR); Tkachenko, I. M.; Smetnik, V. P.; Verulashvili, Ya. V. *Akush. Ginekol.* (2): 8-14; 1976.

The cerebral electric activity was studied in 76 menopausal women before, after 5, 10, 15, 20 and 25 pulse current treatment sessions, and 4-6 mo after the treatment. The current intensity was 0.5-0.8 mA, at a frequency of 300-600 Hz, and a pulse duration of 0.5 msec. The current contained an additional galvanic component. The electrodes were placed in the frontomastoidal region. The pulse current therapy resulted in an improvement of the general well-being, in normalization of the arterial pressure, reduced irritability, and disappearance of congestion. Normalization of the electroencephalogram (EEG) was observed in most abnormal cases. Regardless of the original EEG pattern before the therapy, the pulse current treatment caused stereotypical changes in the EEG; appearance of alpha-waves when they had been absent, increase in the alpha-wave amplitude and duration, irradiation of the alpha-waves into the temporal regions of the cerebrum, and its synchronization in all regions. Correlation was established between the clinical improvement and the normalization of the EEG. The therapeutic effect of pulse current on menopausal symptoms is thought to be due to its direct action on the neuroendocrine and vascular systems. (15 refs.)

4696 MEDICAL CONTROL OF MEN WORKING WITHIN ELECTROMAGNETIC FIELDS. (Eng.) Malboysson, E. (Hidroelectrica Espanola S.A.). *Rev. Gen. Electricite (Numero Special)* 85: 75-80; July, 1976.

Periodic medical examination data and absenteeism rates were analyzed for 84 workers exposed to electric fields at transformer stations or near high voltage lines (up to 400 kV) and 94 linemen working on low voltage overhead lines. The first group showed a higher incidence of digestive, nervous, and locomotor system disorders; however, differences in the living and working habits of these two groups might also explain the different rates. Absenteeism due to illness was greater for the second group, thus confounding the significance of the above findings. It is concluded that electromagnetic fields caused no lasting pathologic effects in the workers, since no biochemical changes were observed. (No refs.)

4697 RESEARCH CARRIED OUT IN ITALY BY ENEL ON THE EFFECTS OF HIGH VOLTAGE ELECTRIC FIELDS. (Eng.) Cerretelli, P. (Inst. Human Physiology, Univ. Milan, Milan, Italy); Malaguti, C. *Rev. Gen. Electricite (Numero Special)* 85: 65-74; July, 1976.

The effects of high voltage electric field exposures on experimental animals were investigated. Anesthetized rabbits were exposed to 80 kV/m electric fields at a frequency of 50 Hz for periods varying from a few minutes to about 500 hr. No significant alterations in cardiac output, heart rate, or arterial blood pressure during acute exposures were observed, although the last cardiovascular parameter tended to be elevated in animals receiving chronic exposures. Increases in heart rate were observed in a conscious dog exposed to 25 kV/m during the first 10 sec after a change in electric field. Slight changes in the total and differential white cell count were observed in rats and dogs exposed to electric fields of 100 and 25 kV/m, respectively; the dogs also showed a fall in hemoglobin concentration and red cell count. Male rats exposed to an electric field of 100 kV/m for acute exposures of 30 min/day and chronic exposures of 8 hr/day over a total period corresponding to the complete maturation cycle of the germinal cells showed no change in gonadal function; however, diminished libido was observed during acute exposures. No embryotoxic or teratogenic effects were observed in the first generation progeny of male rats subjected to acute (30 min/day) or chronic (8 hr/day) exposures of 100 kV/m. Likewise, no changes in the macro- or microscopic structure of the liver, kid-

neys, lungs, heart, spleen, pituitary gland, thyroid gland, adrenal glands, prostate, seminal vesicles, testicles, cervical lymph nodes, or stomach were observed in rats subjected to acute and chronic exposures of 100 kV/m. (6 refs.)

4698 BIBLIOGRAPHIC STUDY ON THE ELECTRIC AND MAGNETIC FIELD EFFECT ON LIVING ORGANISMS. (Eng.) Cabanes, J. (30, avenue de Wagram, 75008 Paris, France). *Rev. Gen. Electricite (Numero Special)* 85: 27-30; July, 1976.

A bibliography of 145 documents dealing with the effects of electric and magnetic fields on living organisms is presented. Specific topics covered include: occupational exposures to electric fields, the ecologic influence of electric fields, the dynamics of low frequency magnetic fields, the effects of electromagnetic fields on patients with cardiac pacemakers, the development of safe working procedures for persons occupationally exposed to electromagnetic radiation, central nervous system effects in animals exposed to extremely low frequency magnetic fields, the locomotor activity of animals exposed to high tension alternating fields, the effects of low frequency electric fields on plant growth, devices for measuring the intensity of alternating current electric fields, the interaction of extremely low frequency electromagnetic fields with brain organelles, the effects of electrical currents on *Escherichia coli* growth rates, displacement currents to the human body resulting from dielectric fields under overhead lines, the absorption of electromagnetic energy in body tissues, the mechanism of the behavior of cells in an alternating electric field, and the influence of weak electromagnetic fields on human circadian periodicity. (145 refs.)

4699 CHANGES OF THE ACTIVITY OF SUCCINATE DEHYDROGENASE IN CELLS OF VARIOUS BRAIN STRUCTURES UNDER THE EFFECT OF UHF FIELD OF LOW INTENSITY. (Rus.) Belokrinitsky, V. S. (A. N. Marzeev Kiev Scientific Res. Inst. General and Communal Hygiene, Kiev, USSR); Nikitina, N. G. *Vrach. Delo* (3): 127-131; 1976.

Changes in the succinate dehydrogenase activity of cells of the archipallium, paleopallium, neocortex, subcortical structures, vascular plexes of the ventricles, ependyma and pia mater of the brain were studied in 99 sexually mature male rats during 1- to 4-mo exposure to low-intensity UHF electromagnetic field with 10-1,000 mW/cm^2. The animals were exposed to the electromagnetic field on work days more than three times daily for 40 min. Considerable field intensity-dependent increase was observed in the succinate dehydrogenase activity following a 30-day exposure in all brain structures. The smallest increase was in the nucleus caudatus and subiculum, and the field intensity had little effect on the activity increase in Ammon's horn. The enzyme activity decreased at the end of a 60-day exposure to show increased values again at the end of the 4-mo exposure. The changes in the enzyme activity were dependent on field intensity, exposure time, and the specific anatomic sites. (10 refs.)

4700 EFFECT OF MAGNETIC AND ELECTRIC FIELDS ON THE GROWTH AND RATE OF MUTATIONS OF VARIOUS MICRO-ORGANISMS. (Eng.) Riviere, J. (Natl. Agricultural Coll., Paris-Grignon, France). *Rev. Gen. Electricite (Numero Special)* 85: 98-101; July, 1976.

The effect of magnetic and electric fields on the mutation rate and growth of the bacterium *Escherichia coli* and the fungus *Penicillium chrysogenum* was investigated. Electric fields ranging from 10-200 kV/m were generated between two circular metal plates situated in an incubator. The magnetic field experiments involved exposing the above microorganisms to 50-Hz alternating magnetic fields ranging from 10-350 times the earth's magnetic field. The exposure time was 48 hr. Neither mutation rate nor growth rate of the above organisms changed during exposure to magnetic or electric fields, even at the maximum dosages applied. (No refs.)

4701 BIOLOGICAL EFFECTS OF ELECTRIC FIELDS. (Eng.) Kornberg, H. A. (Electric Power Research Inst., Palo Alto, CA 94303). *Rev. Gen. Electricite (Numero Special)* 85: 51-64; July, 1976.

Results from experiments investigating the effects of high voltage fields on humans and animals are reviewed. Studies in the Soviet Union on 319 men working in 220, 330, and 500 kV switchyards revealed nonspecific central nervous system disturbances. Similar observations were reported from Spain where 8 or 9 switchyard workers were transferred to a new 500 kV station and several of them complained of headaches, drowsiness, fatigue, and nausea. In contrast, a review of seven studies performed in the U.S. and Western Europe reveals no adverse effects in humans exposed to fields as high as 20 kV/m (50 hz) for 45 min. These studies also revealed no adverse effects in humans exposed to 60 Hz fields from 765 kV lines. Laboratory studies with animals involving exposures as high as 160 kV/m (60 Hz) over 1500 hr also have revealed no adverse effects. However, the progeny of mice exposed to the above field strength showed a slightly slower growth rate than controls, which could have been due to differences in water availability and temperature. Research in the U.S. and Western Europe has not reproduced the adverse effects noted in Soviet and Spanish studies. (19 refs.)

4702 IMMEDIATE EFFECT OF ELECTRIC CARDIOVERSION ON THE INDICES OF HEMODYNAMICS AND MYOCARDIUM CONTRACTILITY IN PATIENTS WITH AURICULAR FIBRILLATION. (Rus.) Bogoslovsky, V. A. (A. L. Miasnikov Inst. Cardiology, USSR Acad. Medical Sciences, Moscow, USSR); Kukharchuk, V. V.; Mazaev, A. V.; Pichugin, V. N. *Ter. Arkh.* 47(4): 100-104; 1976.

The effect of cardioversion, using a 4,700 V defibrillator, on the indices of central hemodynamics was studied in 29 patients with left atrial fibrillation. The patients were administered phenobarbital and anesthetized with hexenal. The minute volume showed no change 25-30 min after the restoration of the sinus rhythm. However, the frequency of the cardiac contractions decreased and the systolic volume increased after cardioversion. The reduction in the Sonnenblick-Feragut contractility indices was believed to be due to the adverse effect of the electric discharge on the myocardium, and partly to the hexenal anesthesia. (18 refs.)

4703 CERVICAL ENDOMETRIOSIS AS A COMPLICATION AFTER DIATHERMIC COAGULATION OF THE UTERINE CERVIX. (Bul.) Karagiosov, I. (Medical Acad., Maternity and Pediatric Center, Bulgaria); Makaveeva, V. *Akush. Ginekol. (Sofia)* 14(3): 203-208; 1975.

A study of the incidence and colposcopic morphology of cervical endometriosis as a complication of diathermic coagulation (not described) of the uterine cervix is presented. Of 5,531 women examined colposcopically, 40 (.72%) showed evidence of cervical endometriosis. All cases occurred in patients in whom diathermal coagulation had been performed (40/636 patients, 6.28%). Pseudotumors, flat, ulcerous and pseudoectopic forms of cervical endometriosis were distinguished colposcopically. (14 refs.)

4704 CONFORMATIONAL EFFECTS ON THE ACTIVATION FREE ENERGY OF DIFFUSION THROUGH MEMBRANES AS INFLUENCED BY ELECTRIC FIELDS. (Eng.) Offner, F. F. (Technological Inst., Northwestern Univ., Evanston, IL 60201); Kim, S. H. *J. Theor. Biol.* 61: 97-112; 1976.

The influence of an electric field on the permeability of biologic membranes to potassium and sodium ions is theoretically analyzed. Permeability changes in membranes are explained by simple electrostatically induced conformational changes at the mouths of membrane pores, which result from the deflection of long-chain molecules having ionized polar groups near the interface. The deflection of such a chain increases approximately as the cube of the number of deflecting atoms in the chain increases. Such a molecule will suffer a considerable deflection if subjected to a component of an electric field normal to its axis. For example, a 20-atom chain would deflect 1.0 Angstrom as a result of a normal field component of 100,000 V/cm acting on a single electron charge. A conformational change requiring a low free energy for its production may result in a large change in the free energy of activation. This difference is due to the time scale of the two processes: the electrical displacement can occur over a relatively long time (fraction of a msec), while the process affecting activation energy occurs over a time scale on the order of 10^{-12} sec. Thus the activation energy for diffusion through pores should be highly sensitive to the boundary electric field, provided that the pore opening is of a suitable form and carries charges at the interface. The energy required to partially dehydrate sodium and potassium ions plays an essential role in the process. (22 refs.)

4705 MYOSIN SYNTHESIS INCREASED BY ELECTRICAL STIMULATION OF SKELETAL MUSCLE CELL CULTURES. (Eng.) Brevet, A. (Dept. Medicine, Stanford Univ. Medical Center, Stanford, CA 94305); Pinto, E.; Peacock, J.; Stockdale, F. E. *Science* 193(4258): 1152-1154; 1976.

The effect of electrical stimulation (100 V and 5 mA maximum) on protein synthesis in skeletal muscle cell cultures established from 12- to 13-day embryonic chick breast muscle was investigated. When the muscle cultures were 4-5 days old, they were stimulated for 14-48 hr with a 0.6-sec train of 10- to 25-msec biphasic pulses delivered every 4 sec by way of agar saline bridges. The quantity of protein extracted from the cultures with pyrophosphate buffer was increased by a mean of 21% over that of unstimulated control cultures, and the amount of radioactive leucine in myosin heavy chain protein was increased by a mean of 39% over controls. A 29% increase in the pyrophosphate-extractable protein as compared with only a 7% increase in total cellular protein indicated that the electrical stimulation effect was greater on contractile proteins, such as myosin. A comparison of the deoxyribonucleic acid content of stimulated and unstimulated cultures revealed that the protein enhancement in stimulated cultures was due to increased protein synthesis rather than to cell proliferation. Thus, direct electrical stimulation of the contraction of skeletal muscle cells *in vitro* enhances the amount of protein produced by myotubes, and this increase is greater for the contractile proteins. (26 refs.)

4706 ELECTRIC FIELD-INDUCED CONFORMATIONAL CHANGE OF POLY(L-LYSINE) STUDIED BY TRANSIENT ELECTRIC BIREFRINGENCE. (Eng.) Kikuchi, K. (Dept. Chemistry, Coll. General Education, Univ. Tokyo, Meguroku, Tokyo, Japan); Yoshioka, K. *Biopolymers* 15(9): 1669-1676; 1976.

Transient electric birefringence measurements on poly (L-lysine hydrobromide) in methanol-water mixtures were carried out at various solvent compositions in the vicinity of the helix-coil transition region (from 87 to 98 vol % methanol). The electric field was applied to the solution in a Kerr cell in the form of single rectangular pulses of up to 6 kV amplitude. Anomalous birefringence transients were observed between 90 and 95 vol % methanol above a threshold field strength. A distinct difference between the responses to weak and strong electric fields was noticed over a narrow range of the solvent composition. The effects of polymer concentration and temperature on the field-strength dependence of the birefringence were studied at a solvent composition of 90 vol % methanol where the anomalous transients

appeared most clearly. The double logarithmic plots of the steady-state specific birefringence versus the square of field strength for different concentrations and temperatures could be superimposed by shifting them horizontally along the abscissa. The threshold field strength, which was determined from the shift factor, decreased with decreasing concentration. The results provide further evidence that strong electric fields can cause a helix-coil transition in this system under favorable conditions. (17 refs.)

4707 EXPERIMENTAL AND THEORETICAL STUDIES ON ELECTROMAGNETIC FIELDS INDUCED INSIDE FINITE BIOLOGICAL BODIES. (Eng.) Guru, B. S. (Dept. Electrical Engineering and Systems Science, Michigan State Univ., East Lansing, MI 48824); Chen, K-M. *IEEE Trans. Microwave Theory Tech.* MTT-24(7): 433-440; 1976.

The tensor integral equation was used to calculate the induced electric field inside a biologic body illuminated by a simple plane wave. Simulated biologic bodies made of plexiglas were filled with saline and put into an anechoic chamber and illuminated by electromagnetic waves with frequencies ranging from 1.7-3.0 GHz radiated from a horn antenna. The induced electric field inside the solution was measured by a dipole-type probe loaded with a microwave detector diode at the terminal. Model sizes were 6x6x1 cm, 12x12x1 cm, 16x16x1 cm, and 12x12x2 cm. Results of the theoretic and experimental values of the dissipated power (DP) are presented graphically. The distribution of the DP was shown to change significantly when frequency, conductivity and permittivities changed only slightly. In the model 2 cm deep (two 1 cm layers) the DP in the first layer was several decibels higher than that in the second layer, as was theoretically predicted. The patterns of the DP indicated the complexity of the induced field in the models. (10 refs.)

4708 TUMOR ERADICATION BY RADIOFREQUENCY THERAPY [Letter to Editor]. (Eng.) Selker, R. G. (Univ. Pittsburgh, Pittsburgh, PA); Wolfson, S. K. *JAMA* 236(15): 1690-1691; 1976.

A report of tumor eradication by radiofrequency therapy is questioned because of problems associated with tumor temperature measurement and the assumption that all tumors have decreased blood flow. Most temperature measuring devices are directly heated in the radiofrequency field and give false readings of intratumoral events; therefore, special thermistors must be used to prevent distortion of the absolute temperature values produced. A review of the conflicting reports in the literature concerning the effect of radiofrequency therapy on tumor eradication illustrates the importance of the above temperature measurement precautions. At 40°C, for example, enhanced tumor growth with metastatic implants and rapid death occur in experimental animals. That the results of radiofrequency-induced tumor eradication are totally related to tumor blood flow is doubtful, and in the absence of data outlining intratumoral temperatures, necrosis related to high temperatures seems more reasonable. Total tumor necrosis can occur within minutes after the application of radiofrequency heat. (5 refs.)

4709 COMPLEX PERMITTIVITY AND PENETRATION DEPTH OF MUSCLE AND FAT TISSUES BETWEEN 40 AND 90 GHz. (Eng.) Edrich, J. (Dept. Electrical Engineering, Univ. Denver, Denver, CO 80210); Hardee, P. C. *IEEE Trans. Microwave Theory Tech.* MTT-24(5): 273-275; 1976.

The dielectric constant (ε), conductivity (σ), and penetration depth (δ) of millimeter waves in fat and muscle tissue were measured over the frequency bands 40-54 GHz and 85-90 GHz. Fat from recently slaughtered cattle, and muscle tissue from Sprague-Dawley rats, were used for measurements. The measured δ of fat at 40-54 GHz and 85-90 GHz ranged from approximately 1.8-2.5 mm (peak at 45 GHz) and from approximately 1.2-1.3 mm (peak at 90 GHz), respectively. The δ for muscle in the two frequency bands ranged from approximately .4 to .27 mm (peak at 40 GHz) and from approximately .22 to .21 mm (peak at 85 GHz). A phaseless technique was used to determine the relative ε and the σ for the tissues. A substantial shift in the characteristics of fat was determined by these values. The initial values for ε and σ increased from 8.4 and 15 Ω^{-1} m^{-1} respectively, for about 1.5 hr, after which they shifted downward to 4 and 7 Ω^{-1} m^{-1}. This shift did not seem to be affected by temperature. The results indicate that millimeter wave irradiation of human body tissue similar to that investigated has to be considered for microwave hazard studies. (11 refs.)

4710 EXPERIMENTAL REGENERATION IN PERIPHERAL NERVES AND THE SPINAL CORD IN LABORATORY ANIMALS EXPOSED TO A PULSED ELECTROMAGNETIC FIELD. (Eng.) Wilson, D. H. (Accident and Emergency Dept., General Infirmary at Leeds, Leeds, England); Jagadeesh, P. *Paraplegia* 14: 12-20; 1976.

The use of pulsed electromagnetic fields for peripheral nerve and spinal cord regeneration in laboratory animals was investigated. The apparatus used was a Diapulse machine that is capable of delivering field strengths of from 5-120 mW/cm^2 in the form of 65-microsec pulses over frequencies of 80-600 pulses/sec. Peripheral nerve section and suture (median-ulnar nerve in the upper forelimb) was performed on 132 rats, and postoperatively half of the rats were treated for 15 min/day with diapulse therapy (dosage not given). The diapulse-treated animals demonstrated a return of nerve conduction 12 days after division and suture of the nerve, although a 10-fold increase in stimulus strength (0.5-5.0 V) was required for the response. No responses to the 5.0-V stimulation were observed in control animals. Histologic sections distal to the point of suture in the treated animals 30 days after surgery showed

chat the nerve contained abundant regenerating nerve fibers but of reduced diameter. Comparable sections from untreated animals 60 days after division and suture also showed regeneration, but the degree of recovery was not as great as that in treated animals at 30 days postoperative. Studies of spinal cord regeneration following hemicordotomy in cats were also performed. Exposures to diapulse therapy were for 0.5 hr each day for 1 mo using an average field strength of 50 mW/cm^2 and a frequency of 400 pulses/sec. When the animals were sacrificed 3 mo after hemicordotomy, electromagnetic-induced nerve fiber regeneration across the scar region was observed. (6 refs.)

4711 THE EFFECT OF 1.6 GHz RADIATION ON NEUROTRANSMITTERS IN DISCRETE AREAS OF THE RAT BRAIN. (Eng.) Merritt, J. H. (Radiobiology Div., U.S. Air Force Sch. Aerospace Medicine, Brooks Air Force Base, TX); Hartzell, R.; Frazer, J. H. *In: Proceedings of the 1975 Annual Meeting of the International Union of Radio Science Held at the University of Colorado, Boulder, Colorado, 20-23 October, 1975.* USNC/URSI. (Washington, D.C.): 227-228; 1975.

To investigate the effects of radiofrequency radiation on the central nervous system of rats, power distribution was thermographically determined in rats exposed to 1.6 GHz radiation at a measured power density of 80 mW/cm^2 for 10 min. Rectal temperature rise was 4°C. Serotonin and its metabolite 5-hydroxyindole acetic acid, dopamine and its metabolite homovanillic acid, and norepinephrine were measured in the hypothalamus, corpus striatum, midbrain, hippocampus, cerebellum, medulla-pons, and cortex. Parallel hyperthermal and normothermal controls were also exmained. The hyperthermal controls were maintained in a 75°C environment for 10 min which resulted in a rectal temperature rise of 4°C. A significant decrease in hypothalamic norepinephrine content was noted in the irradiated and hyperthermal groups compared to the normothermal controls. The hippocampal content of serotonin was decreased in the irradiated but not the hyperthermal animals. Conversely, cerebellar and cortical serotonin concentrations were decreased in the hyperthermal but not the irradiated rats. The dopamine content of the corpus striatum was significantly lower in the irradiated group but not in the hyperthermal animals. The decrease in hypothalamic norepinephrine supports other data suggesting that neurotransmitter subserves a neuronal system to lower body temperature. The other changes agree with thermographic imagery of rats exposed to 1.6 GHz radiation. The results indicate that the effects on the neurotransmitters are a result of radiofrequency radiation induced hyperthermia and not a direct effect on innervated tissue. (No refs.)

4712 THE EFFECT OF 1.6 GHz CW FIELDS ON TRACE METAL CONTENT OF SPECIFIC REGIONS OF RAT BRAIN. (Eng.) Chamness, F. (U.S. Air Force Sch. Aerospace Medicine, Brooks Air Force Base, TX); Scholes, H.; Sexauer, S.; Frazer, J. W. *In: Proceedings of the 1975 Annual Meeting of the International Union of Radio Science Held at the University of Colorado, Boulder, Colorado, 20-23 October, 1975.* USNC/URSI. (Washington, D.C.): 226; 1975.

To study the effects of radiofrequency radiation on the trace metal content of specific regions of the rat brain, rats were exposed to 80 mW/cm^{-2} plane wave fields at 1.6 GHz in the USAFSAM anechoic chamber. Companion studies were made on the brains of animals exposed to an environment of 80°C in a warm air oven for an equivalent period of time. Brain areas analyzed included the cortex, corpus striatum, hippocampus, hypothalamus, midbrain, cerebellum, and medulla. Metals analyzed were Na, K, Ca, Mg, Fe, Cu, and Zn, all by atomic absorption. Major differences from controls were found in the magnesium content of the hypothalamus in both hyperthermal and radiofrequency exposed rats. If the iron changes are interpreted as due primarily to alterations in blood distribution, then it appears that intracerebral circulatory changes were produced by hyperthermal environments which were not produced by radiofrequency exposure. Previous studies have found decreases in zinc content in liver and increases in the zinc content in brain cortex of animals exposed to high frequency band radiation. The present results are similar to the latter findings and show that some cerebral effects are produced indirectly as a result of primary effects on other organs. (No refs.)

4713 EFFECTS OF THE FIELD FREE SPACE ON THE CIRCADIAN RHYTHM OF THE HOUSE SPARROW, *PASSER DOMESTICUS*, AND OF THE SONG SPARROW, *MELOSPIZA MELODIA*. (Eng.) Bliss, V. (Dept. Zoology, Univ. Rhode Island, Kingston, RI); Heppner, F. *In: Proceedings of the 1975 Annual Meeting of the International Union of Radio Science Held at the University of Colorado, Boulder, Colorado, 20-23 October, 1975.* USNC/URSI. (Washington, D.C.): 268; 1975.

Experiments were performed to test the hypothesis that changes in the earth's electromagnetic field can act as a Zeitgeber for birds that normally demonstrate pronounced circadian rhythms. Two identical Helmholtz coils were constructed, each containing eight nonmagnetic cages arranged symmetrically within the computed field-free space. The birds' activity was monitored with an event recorder. The experiment was conducted in a soundproof room at a constant temperature. Oscillations in background noise from the power supply and recording apparatus were masked by a white noise generator. Eight birds (one bird/cage) were placed in each coil. Each group consisted of four House Sparrows and four Song Sparrows. All birds were entrained to an LD 9:15 cycle. The experimental group was placed on an electromagnetic field 9:15 cycle (9 hr field-free space: 15 hr earth's electromagnetic field) that coincided with the LD cycle. All birds were maintained at the LD 9:15 cycle. After several weeks, all birds were placed in constant darkness. The electromagnetic field 9:15 cycle was maintained for the experimental group, and all activity was tested for periodicity. (No refs.)

4714 BROADCAST RADIATION: A SECOND LOOK. (Eng.) Tell, R. A. (Environmental Protection Agency, Washington, DC); Janes, D. E. *In: Proceedings of the 1975 Annual Meeting of the International Union of Radio Science Held at the University of Colorado, Boulder, Colorado, 20-23 October, 1975.* USNC/URSI. (Washington, D.C.): 312-313; 1975.

As part of its program to determine the health and environmental effects of exposure to nonionizing radiation, the Environmental Protection Agency is gathering and analyzing information on sources that produce radiation levels in the environment. This paper extends the results of a previous project that studied broadcast stations as environmental sources of nonionizing radiation. This investigation was developed around vertical radiation patterns and data supplied by the Federal Communications Commission regarding the heights of transmitting antennas above ground and above supporting structures, such as, building roofs. In particular, power densities at roof and ground level were calculated for areas very near FM broadcast installations using recent information on steep depression angle radiation from commonly used FM transmitting antennas. Associated field measurement data are also discussed and the overall implications of this analysis are examined in terms of present radiofrequency exposure standards and philosophy. (No refs.)

4715 EIGHTH SUPPLEMENT TO BIBLIOGRAPHY OF REPORTED BIOLOGICAL PHENOMENA ('EFFECTS') AND CLINICAL MANIFESTATIONS ATTRIBUTED TO MICROWAVE AND RADIO-FREQUENCY RADIATION. (Eng.) Glaser, Z. R. (Naval Medical Research Inst. Detachment at Naval Surface Weapons Center, Dahlgren Lab., Dahlgren, VA 22448); Brown, P. F. *Prepared by Dahlgren Laboratory for the Naval Medical Research & Development Command, Bethesda, MD.* AD 734-391: 19 pages, August, 1976.

Approximately 350 references on the biological responses to radiofrequency and microwave radiation are included in this continuing bibliography of the world literature. Citations include such topics as biomedical studies using electromagnetic pulse radiation, biological dosimetry, effects of electromagnetic radiation on implanted electronic cardiac pacemakers, microwave exposure limits, regulations and standards, and electroanesthesia. Particular attention is paid to the effects of nonionizing radiation on man. Soviet and East European literature is included in detail. (331 refs.)

AUTHORS OF CURRENT LITERATURE INDEX

ADEY, W. R.
4636
AL-BADWAIHY, K. A.
4630, 4647
ALBERT, E.
4601
ALLEN, S.
4660
ALLIS, J. W.
4616
ARLEVSKY, I. P.
4678
ASH, N.
4663
BENANE, S. G.
4631
BARBER, P. W.
4687
BARNES, F. S.
4659
BAWIN, S. M.
4636
BECK, G. S.
4688
BEISCHER, D. E.
4632
BELOKRINITSKY, V. S.
4699
BENTALL, R. H. C.
4684
BERTHARION, G.
4644
BEZUGLOV, V. K.
4678
BIRENBAUM, L.
4652
BLACKMAN, C. F.
4631
BLASCO, A. P.
4625
BLISS, V.
4713
BOGOSLOVSKY, V. A.
4702
BOWDEN, D. M.
4627
BREVET, A.
4705
BROWN, P. F.
4715
BURCH, L. S.
4622
BURKS, D. G.
4624
BEZUKIN, V. G.
4678
CABANES, J.
4677, 4698
CALDWELL, R.
4659
CARPENTER, R. L.
4607, 4633
CARTY, M. J.
4668
CERRETELLI, P.
4697
CHAMNESS, F.
4712
CHARYULU, K. K. N.
4661
CHEN, K. C.
4654
CHEN, K. -M.
4707
CHERNYSHEVA, O. N.
4675
CHEUNG, A. Y.
4691
CHOU, C. K.
4609, 4656
CLEARY, S. F.
4612
CORDINER, J. W.
4668
DAGE, E. L.
4602
D'ANDREA, J. A.
4641
DE LORGE, J. O.
4603
DETHLEFSEN, L. A.
4637
DODGE, C. H.
4619
DUMANSKII, YU. D.
4670
DURFEE, W. K.
4635
DURNEY, C. H.
4660
ECKSTEIN, H. B.
4684
EDRICH, J.
4709
EICHERT, E. S.
4667
ELDER, S. T.
4606
EMERY, A.
4665
EMERY, A. F.
4620
ERIKSSON, C.
4694
EVTUSHENKO, G. I.
4675
FEOLA, J. M.
4662
FERRI, E. S.
4626, 4636
FRAZER, J. H.
4711
FRAZER, J. W.
4621, 4666, 4712
FREY, A. H.
4667
FROMME, M. L.
4616
GALAKTIONOVA, G. V.
4676, 4682
GALAMBOS, R.
4609, 4634
GANDHI, O. P.
4641, 4688, 4693
GILLARD, J.
4644
GITHENS, S. H.
4648
GLASER, Z. R.
4619, 4639, 4640, 4715
GOODMAN, E. M.
4649
GORDON, G. A.
4637
GRAF, E. R.
4624
GREENBERG, B.
4663
GREENEBAUM, B.
4649
GRISSETT, J. D.
4686
GROVE, H. M.
4693
GRUENNER, O.
4672
GUILLET, R.
4629
GURU, B. S.
4707
GUY, A. W.
4604, 4609, 4620, 4634
4656, 4665, 4666
HAGAN, G. J.
4607, 4626, 4633

HARDEE, P. C.
4709
HARRIS, C.
4665
HARTZELL, R.
4711
HAUF, R.
4674
HAWKINS, T. D.
4623, 4642, 4645, 4648
HEPPNER, F.
4713
HILL, D. H.
4600
HO, H. S.
4646, 4650
HOLLAND, M. G.
4606
HOUK, W. M.
4632, 4686
HSIEH, S. T.
4653
HU, C. L.
4659
HUNT, E. L.
4645, 4688
JAGADEESH, P.
4710
JAGANNATHAN, N.
4690
JANES, D. E.
4714
JOHNSON, C. C.
4660
JOHNSON, R. B.
4634
JOINES, W. T.
4618

PRECEDING PAGE BLANK-NOT FILMED

JONES, S.
4694
JOSHI, R.
4602
KAPLAN, I. T.
4652
KARAGIOSOV, I.
4703
KELLOGG, R. B.
4600
KEY, M.
4661
KIKUCHI, K.
4706
KIM, S. H.
4704
KINDT, C. W.
4627
KOLODUB, F. A.
4675
KOOPMAN, D. W.
4691
KORNBERG, H. A.
4701
KRAMER, P.
4665
KRANING, K. K.
4620
KRITIKOS, H.
4605
KUKHARCHUK, V. V.
4702
LAM, C. -K.
4610
LE VEEN, H. H.
4681
LEICHER-PREKA, A.
4646
LENOX, R. H.
4693
LIN, J. C.
4610, 4654, 4657
LIPSCOMB, R. J.
4606
LIVINGSTON, G.
4637
LONGACRE, A., JR.
4686
LOTZ, W. G.
4629, 4643
LOVELY, R. H.
4604, 4634, 4656
LU, S. -T.
4611
MACDOUGAL, J.
4666
MACKAY, C.
4668
MAGIN, R. L.
4611
MAKAVEEVA, V.
4703
MALAGUTI, C.
4697
MALBOYSSON, E.
4696
MANTHEI, R. C.
4640
MARRON, M. T.
4649
MARTIN, P.
4635
MASSOUDI, H.
4660
MATHEWSON, N. S.
4625
MAXEY, E. S.
4689
MAY, J. G.
4606
MAZAEV, A. V.
4702
MCAFEE, R. D.
4606
MEDICI, R. G.
4614
MERRITT, J. H.
4711
METLAY, W.
4652
MEYERHOFF, J. L.
4693
MICHAELSON, S. M.
4611, 4617, 4629, 4632
4643
MIKOLAJCZY, H.
4658
MIZUNO, K.
4615
MOE, K. E.
4604
MONAHAN, J. C.
4650
MORGAN, M. K.
4627
MURACA, G. J., JR.
4638
MUTHUKRISHNAN, S.
4635
MYERS, D.
4634
NATARAJAN, K.
4690
NEUDER, S. M.
4600
NIKITINA, N. G.
4699
OBRENOVITCH, J.
4644
OFFNER, F. F.
4704
O'GRADY, T. C.
4639
OLIVA, S. A.
4625
OOSTA, G. M.
4625
OSCAR, K. J.
4642
OSTROVSKAIA, I. S.
4675
OTT, V. R.
4679
PEACOCK, J.
4705
PERRIN, J. C.
4644
PERSIANINOV, L. S.
4695
PICHUGIN, V. N.
4702
PIERLUISSI, J. H.
4692
PINTO, E.
4705
PLANTE, P. R.
4635
POLK, C.
4635
PYLE, S. D.
4659
RABINOWITZ, J. R.
4651
REGELSON, W.
4628
RIVIERE, J.
4700
ROSENTHAL, S. W.
4652
RUDICHENKO, V. F.
4669, 4670
RUSCH, D.
4679
RYAN, J. J.
4685
RYZHOV, A. I.
4680
SAKHAROVA, S. A.
4680
SANDLER, S. S.
4664
SCHOLES, H.
4712
SCHROT, J.
4623, 4648
SEAMAN, R. L.
4618
SEDIGH, K.
4688
SELKER, R. G.
4708
SERVANTIE, A. M.
4644
SERVANTIE, B.
4644
SETO, Y. J.
4653
SEXAUER, S.
4712
SHINN, D. H.
4673
SHORT, R.
4620
SMETNIK, V. P.
4695
SMIALOWICZ, R. J.
4608
SOROCHKIN, A. I.
4671
SOUHEAVER, G. T.
4685
SPELMAN, F. A.
4627

SPIEGEL, R. J.
4613
STOCKDALE, F. E.
4705
STRZHIZHOVSKY, A. D.
4676, 4682
SUGIYAMA, S.
4615
SURLES, M. C.
4631
TAKASHIMA, S.
4605
TELL, R. A.
4714
THOMAS, J. R.
4622
TIMCHENKO, A. N.
4675
TKACHENKO, I. M.
4695
TRABCULAY, E. A., JR.
4655
UDINTSEV, N. A.
4680
VARMA, M. M.
4602, 4655
VERULASHVILI, YA. V.
4695
WACHTEL, H.
4618
WEBB, M.
4666
WEST, B.
4628
WILSON, D. H.
4710
WOLFSON, S. K.
4708
WOOLAS, K. D.
4683
WU, C. -L.
4657
YEANDLE, S. S.
4622
YOSHIOKA, K.
4706
YOUSSEF, A. -B.
4630, 4647
ZARET, M. M.
4652